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equal good in its line. Electricians are alive to the importance of this work also, and the indications are that they will have much influence in its settlement.

But since at the present time there are writers on space analysis who see nothing but vectors, and other writers who identify vectors with quadrantal quaternions, and since the principles commonly accepted by Quaternionists are not free from fundamental errors, it is evident that much time is still required for the discussion of principles before definite decisions about notation can be arrived at. The notation which is adopted must be built on an adequate analysis if it is to be lasting. And here the π muddle in the system of electric and magnetic units ought to act as a warning to make haste slowly.

The logical harmony and unification of the whole of mathematical analysis ought to be kept in view. The algebra of space ought to include the algebra of the plane as a special case, just as the algebra of the plane includes the algebra of the line. And as the algebra of space includes the spherical and higher forms of trigonometry, it ought to be made to harmonize as much as possible with the existing notations and conventions of trigonometrical analysis. When vector analysis is developed and presented so as not to contradict, but, on the contrary, to include the ordinary branches of analysis, we may expect to see many zealous cultivators, many fruitful applications, and, finally, its universal diffusion. Then there will be no need of arguments to prove its utility. May the movement initiated by Messrs. Molenbroek and Kimura hasten the realization of this happy result.

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SCIENTIFIC LITERATURE.

De Saint Louis a Tripoli par le lac Tchad. Par le LIEUTENANT-COLONEL P. L. MONTEIL. Paris, Alcan. 1895. Pp. x. and 463. Fifteen itinerary charts and one general map. Profusely illustrated by Riou.

This book may be considered as the fruit of the treaty between England and France which was entered into on August 5, 1890. The reason for the treaty was the necessity of fixing

a boundary between the regions subject to their respective influences along an imaginary line drawn from Say on the Niger to Lake Tchad.

Monteil proposed to the French government to traverse this region, starting from St. Louis, in the French possessions on the west coast of Africa. His object was to obtain treaties with as many of the native potentates along the route as possible, and thereby fix the boundary as far as France was concerned.

He left St. Louis on October 9, 1890, with one white companion, Adj. Badaire, and twelve natives, four of the latter deserting him quite promptly. For twenty-seven months from this time his experiences are given with considerable minuteness. He had the regulation 'ups and downs' which are the lot of the explorer everywhere, particularly in Africa. As far as Wagodgho he followed the itineraries of Binger and Crozat. Beyond this point everything was relatively unknown, except where light had been thrown upon various points along the line when his path crossed the track of his predecessors, Denham and Clapperton, Barth, Nachtigal and others.

His occupations were numerous, as he was at various times soldier, engineer, physician, botanist, astronomer, cartographer, pharmacist, trader, diplomat and magician. Photography did not prosper with him. His early attempts were crushed in Paris; where his plates going to one office and his letter of instructions to another, they were both opened separately with the consequent disastrous result to the negatives. A final blow was struck at this portion of his work when a native stole his camera, plates and all. One can imagine the 'joy and perplexity' of the average native while examining this piece of apparatus, as well as the feelings of the rightful owner under the circumstances.

The loss, however, is made good by the superb set of illustrations by Riou, which are one of the charms of the volume. The artist has so thoroughly caught the spirit of the author that, much as we regret the absence of the true copies of nature, we feel satisfied by the insight which the skillful sketches give us on the subject.

Another feature of the book which cannot be too highly praised is the series of itinerary

maps, which are inserted in the text of each chapter which is devoted to the description of a portion of the journey.

The book may be divided for practical purposes into two parts—the descriptive and the generalizing portions. His descriptions of men and things, are pleasant reading, and show us a man, wide awake to the meaning of the scenes through which he passed. Space does not permit of a detailed account of these, though many are of great interest and value. Some of the character sketches are very well done. The chapters which are devoted to his generalizations are by all means the best part of his work. They are scattered through the book and bear upon many subjects; geology, botany, natural history and anthropology all come in for a share, and while we may not agree with his conclusions, particularly upon some ethical questions, we cannot but agree that his clear statements of facts and conditions are well worthy of close attention. Some of each of these parts of the work will be referred to in this review.

He was almost uniformly successful in his diplomatic relations with the native chiefs with whom he came in contact. Sometimes under the most trying circumstances he carried his point. His French temperament seems to have been under splendid control, as it only comes to the surface when the pressure of affairs is removed and he feels free to express himself. This is greatly to his credit, and much of what might be called 'good fortune' by some is undoubtedly to be attributed to this fact.

His first treaty was made at San on January 14, 1891. Shortly after this he meets Capt. Quiquanodon and Dr. Crozat at Kinian. They reinforce his party most opportunely with both men and animals. On March 1 he reached Diasa. Here he received his last letters from France, bearing date of December 18, 1890. From this time until he reached Beni-Oulid, on December 6, 1892, he was virtually lost as far as hearing from the outside world was concerned.

An interesting description is given of Bobo-Dioulasso, where the houses are built upon high platforms, where 's'habiller est avoir quelque difformité à cacher,' and where the children

are carried under a 'carapace' of rods. At Souro he has his first real encounter with fetichism, and a good idea is given of its wide ramifications and its effects upon the life and habits of the natives, as well as the consequences which hang over the innocent traveler's head who ignorantly invades the 'sacred limits' which are spread around him like so many snares.

His account of the 'whistle system' of telegraphy, as employed in the Bobo country (p. 107), is curious reading. Imagine the swarthy native taking a siesta at sunset, and carrying on a conversation by this means—arranging for a hunting party in the morning; conducting some piece of business; lovers intoning their pure love ditties; enemies challenging one another, etc., etc., for of such is the 400 of Bobo.

The Mossi country is described on pp. 121 *et seq.* This region on the bend of the Niger, is occupied by a well organized people whose traditions carry them back to the beginning of the world, without exactly fixing the date of this event. Naba, the first of the race, had 333 sons, and divided his kingdom among them at his death. Wagodogho is the seat of the main head of the whole kingdom, and the Naba of this place is the Naba of the Nabas. He wears as an emblem of his proud preëminence, a special head dress which is a species of three decked turban; but this with his very numerous harem, seems to be the limit of his prerogatives.

He reached Wagodogho on April 28, only to be ordered out of town. Protests that he was the envoy of the *king* of France were of no avail. Eventually, a music box, a Persian saddle and a sword, did the business for him, and he was received as a man and brother. He reached Dori on May 22d, and it was high time that he did so, for this was one of the very low points in his curvilinear career. Things were at a very low ebb with him at this point.

While resting at Dori, on what might be called the boarder line between the civilized and the uncivilized nations of central Africa, he gives us a sketch of the relations of Mohammedanism to progress in this part of the world. It seems strange to find him favoring polygamy and slavery, and expressing the opinion that the religion of Islam is so adjusted to the con-

ditions of the country that if peaceful means had been used for its propagation, instead of force, it might not be too much to say that all Africa would now be under the sway of the Moslem faith. The bearings of the two systems of fetichism and Mohammedanism upon the peace of mind of the traveller are portrayed in a most telling manner.

The trip to Say, on the Niger, was accomplished in eight months. Just before reaching Ouro-Gueladjio he passed through one of his darkest periods, some of the journey being made on foot, his animals having been reduced by desertions and death from twenty-five to two, and his men from forty-seven to seventeen.

The question of the Saharan Sea is discussed, on page 199 and the following pages, as viewed from a structural standpoint, with reference to the large basins known as the Dalhols. The trend of these supposed branches of the extinct sea, as well as the existence of the flabelliform Egyptian palm in this exceptional locality, seem to favor the arguments advanced in the text.

Just beyond this point in the book, where he deals with the regions about Argoungou and Sokoto, we pass through one of his brighter periods. With great good fortune he happened to pass through this part of the country during a lull in the proceedings—generally in a disturbed state among these races. A few months later, he would have had a hard time indeed, even if he had escaped with his life from the political 'cloud burst' which took place over the whole of this region. His state of mind is well illustrated by the pretty sentence on page 238, upon the moral effect of sunshine. This also probably accounts for the rather rose-colored description of the Peuls which immediately follows.

In chapter X. (p. 269) there are some good character studies in the course of the account of his stay at Kano. The 'clearing house system' in use among these people is curious enough to be amusing. Articles of fixed value are traded for one another directly, but when *small change* is involved the *trader draws on his bank*. This consists in a mule load of cowrie shells, 50,000 of them composing a load and representing a total value of \$10.

Kano is further the center of the cola nut

trade. This article, which of recent years has been introduced into the medical pharmacopœia, is treated of in numerous aspects. The nut is found in a belt lying between 6° 30' and 11° or 12° North Latitude; and though it may be the 'Coffee of the Soudan' and correspond in all its virtues to the betel nut in India, opium in China, the cigarette of a Spaniard, or the dog of a blind man, it can hardly be accepted as a sort of universal panacea.

At this point we come across the discussion of another phase of the slavery question, viz.: the captives of war. They are captives in name, but slaves in reality, and our author speaks of the amenities of their existence. Their masters are forced to be easy with them, for the reason that some day, through changed fortunes of war, they may in turn occupy the same position. And again, the number of these captives is so great, as contrasted with the number of the freemen, that an insurrection might change the order of things. Such occurrences are not unknown in the political or domestic life of this untamed Eden. The captive is usually held by his captor for a few months, until some mart is reached where he can be disposed of, if he survives the harsh treatment of the march thither. Then, if he is intelligent, he is pushed forward rapidly and can attain to high positions. He is provided with a wife, and his lot becomes settled if he has a family, as neither he nor they can be sold. It is often a matter of good fortune into whose hands he falls. In some instances we read of the 'Captives of the Crown', as being placed in charged of great undertakings and expeditions of all sorts in the Soudan. Hence, at least, so we are told, 'the captive is a social and economic necessity in the Soudan.'

From Kano he sends a courier to Tripoli in the month of January, 1892, and proceeds onward to Kukawa on Lake Tchad, which point was reached on April 10th. His description of the stay at this place, which covered some three and a-half months while he awaited the formation of a caravan to proceed northward, contains many bits of information of value. Here he was subjected to the infamous practice, in the way of the extortion of gifts, which was the means of almost ruining Barth and Nachtigal. Both of these travellers were stranded in

this region by similar delays, and their life blood extracted by the polite but very costly exchange of 'gifts.' Monteil had learned a lesson from their experience, and, secreting sufficient means to carry him through, 'played poor.' The consequences were evident in the great privations to which he was subjected for some time after this. At length his opportunity arrives, a caravan is ready to leave. He makes the sheik a series of presents as farewell gifts, which greatly embarrass that individual to properly and adequately return, which was his immediate duty. The tide was turned in his favor, and he got everything he wanted, and thus escaped this new species of danger with safety.

He speaks very caustically of the rotten and shaky condition of the affairs of Bornu, of which state Kukawa is the chief city. It took only a few months for his prediction of the fall of this empire to be verified.

On August 15, a year after leaving the Niger, he starts on the journey to Tripoli. The caravan of 78 camels, 7 horses, 30 men and 30 slaves must have presented a fine appearance, and their minds must have been much lighter as they started upon the last stage of their trip. Aside from the discussion of the usual tribulations of the long journey over the Sahara, and a rather pathetic description of the evil works of the 'demons of the desert who lead travelers astray,' nothing novel is given in this part of the book.

On December 10, 1892, he reached Tripoli, where his troubles were over. He was welcomed in France in the most cordial and well-deserved manner. His promotion, his medals and other honors have certainly been well earned, and they grace a hard-working, earnest and modest man. The volume contains much more valuable material than is usually found in a book of travels, particularly when written by one who is rather more of a military man and diplomat than a scientist. W. L.

A Laboratory Course in Experimental Physics:

By W. J. LOUDON and J. C. McLENNAN.
Macmillan & Co. 8vo., 300 pp. Price,
\$1.90.

This book is written by the Demonstrator and

the Assistant Demonstrator in Physics in the University of Toronto, and it is evidently designed to meet the special requirements of students in that institution. It is divided into two parts, constituting an elementary course and an advanced course. Part I includes a brief treatment of length-measuring instruments, vernier, cathetometer, spherometer, etc., which is followed by some exercises in density determinations, experiments with pressure and volume of gases and a little about capillarity. The remainder of the elementary course is mostly given to geometrical optics, although there is something of a treatment of photometry and a few exercises in specific and latent heat. The second part treats of acoustics, heat, electricity and magnetism, with a short appendix on gravity and the pendulum. An elementary knowledge of dynamics and the calculus is assumed in the advanced course. In the various experiments described it is generally assumed that a perfectly adjusted piece of apparatus is at hand ready to be set going. The instruments figured and described in the 'acoustics' are from the *atelier* of Rudolph Koenig, and nearly all of the illustrations in the book appear to have been made from perfectly constructed and finished apparatus. It is generally admitted that a large part of the value of the training in a physical laboratory comes from experience in designing, constructing and adjusting apparatus for definite purposes. In no other way can a student so quickly and thoroughly learn the sources of error entering into an experiment, or the methods of eliminating them and in a general way become familiar with the limits of accuracy to which he is restricted. Viewed from this standpoint, such a system as seems to be implied in this book is not to be commended. In fact, it is a little difficult to know under what conditions this book is intended to be used. The authors say in the preface that it owes its origin to the 'difficulty experienced in providing, during a limited time, ample instruction in the matter of details and methods' * * * 'at the present day, when students are required to gain knowledge of natural phenomena by performing experiments for themselves in laboratories.' Although not quite definite, this seems to imply